(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 338 126**
A2

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **88120343.4**

(51) Int. Cl.4: **H04L 1/24**

(22) Date of filing: **06.12.88**

(30) Priority: **22.04.88 US 188771**

(43) Date of publication of application:
25.10.89 Bulletin 89/43

(84) Designated Contracting States:
DE FR GB IT

(71) Applicant: **Hewlett-Packard Company**
3000 Hanover Street
Palo Alto California 94304(US)

(72) Inventor: **Huang, Fred G.**
1538 Zapata Drive
Folsom, CA 95630(US)

(74) Representative: **Liesegang, Roland, Dr. et al**
BOEHMERT & BOEHMERT
Widenmayerstrasse 4/I
D-8000 München 22(DE)

(54) Method and apparatus for testing twisted-pair interconnections of a local area network.

(57) Method and apparatus is disclosed which inexpensively and conveniently tests ordinary twisted-pair (TP) telephone wires (20) installed in a premises for suitably interconnecting elements of a high-speed local area network (LAN). The method eliminates the need to trace the wires or to disturb them in any way. Signals are transmitted onto the near end of the TP wires and are reflected from their open far ends. The received reflected signal from a selected TP wire is compared against the transmitted signal and the TP wire is deemed satisfactory if the comparison shows a bit error rate (BER) less than a predetermined upper limit. Preferably the method is used in conjunction with a directional coupler (34) connected to a transceiver (32) which conducts the signal generated by the transceiver onto the TP wires and conducts the reflected signal from the selected TP wire to a receiver portion of the transceiver.

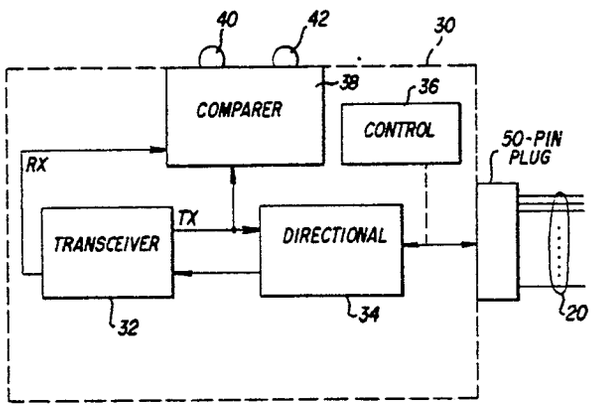

FIG. 3

EP 0 338 126 A2

METHOD AND APPARATUS FOR TESTING TWISTED-PAIR INTERCONNECTIONS OF A HIGH-SPEED LOCAL AREA NETWORK CROSS-REFERENCE TO RELATED, CO-PENDING APPLICATIONS

Co-pending applications of particular interest to the instant application are U.S. Ser. No. 084,960 filed August 13, 1987 on behalf of Fred G. Huang entitled "Crosstalk Reduction in Unshielded Twisted-Pair Lines", U.S. Ser. No. 084,961 filed August 13. 1987 on behalf of Fred G. Huang entitled "Non-Linear Squelch Circuit for IEEE-892.3 Protocol", and U.S. Ser. No. filed on behalf of entitled "Transceiver Coupler for One-Pair Cabling of a High-Speed Network", all commonly assigned with the instant application.

FIELD OF THE INVENTION

The present invention relates to local area network communication circuitry and, more particularly, to a method and apparatus for testing premises twisted-pair telephone wiring for suitability in a high-speed local area network.

BACKGROUND OF THE INVENTION

Fig. 1 illustrates a high-speed local area network (LAN) interconnected by individual unshielded twisted-pair (TP) wires. Related, co-pending application entitled "Crosstalk Reduction in Unshielded Twisted-Pair Lines" contains a description of the use of unshielded TP wires in an IEEE 802.3 LAN allowing transmission speeds of 10 million bits per second (mbps) by employing collision protocol and two different drive levels to reduce crosstalk. Such description is incorporated herein by reference.

Each Pod of the LAN shown in Fig. 1 preferably employs a non-linear squelch circuit described in related, co-pending application entitled "Non-Linear Squelch Circuit for IEEE 802.3 Protocol" and such description is incorporated herein by reference. The squelch circuit avoids false activation of the receiver within the Pod.

The LAN shown in Fig. 1 preferably uses ordinary TP wires such as exist in premises wiring of telephones in office buildings. In this way, expensive and disruptive installation of shielded coaxial cable to interconnect electronic equipment in a LAN is avoided. Standard telephone test equipment can perform tests to determine that there are no shorts or open circuits so that the premises wiring is "useable" for basic telephone needs. Since the high-speed LAN so provided is inexpensive and convenient, it is desirable to test the usable premises telephone wiring in an inexpensive and convenient manner to assure its suitability for use in a high-speed LAN.

Known in the prior art are cable testers which require two skilled technicians and specialized equipment to test for high frequency characteristic needs of high speed network. Normally at one end, a number of cables, such as 25, all originate while the other end of each cable terminates at a remote location within the building. This requires time-consuming identification of the location where each cable terminates and then the positioning of a technician at each end of a cable for testing. Such testing is inconvenient, expensive and partially defeats the purpose of using ordinary TP premises wiring.

What is needed is a convenient inexpensive way of testing existing premises telephone wiring for high speed network and can be performed by a single unskilled person without the need to trace each cable and find the location where it terminates.

SUMMARY OF THE INVENTION

A method of testing existing premises telephone wiring for its suitability in a LAN using unshielded TP wires is provided which can be performed quickly and conveniently by an unskilled person. There is no need to trace each wire pair to locate its termination because the method operates on open lines. A tester is utilized which is connected, in turn, to each pair of TP wires and a test is automatically performed on that pair. The operator simply connects the tester to each pair at its origin, leaving the other end open. A simple visual indication, such as a green light or a red light, will be given by the tester to show whether this pair passed the test.

The tester is, as far as the operator is concerned, a "black box" and his or her understanding of its internal construction is unnecessary. Since the tester is normally needed only once, at the initial installation of the LAN, it need not be purchased, but can be loaned for the particular one-time use, thereby avoiding purchase of a relatively costly device.

The cable tester is preferably constructed as a transceiver employing a directional coupler described in the related, co-pending application "Transceiver Coupler for One-Pair Cabling of a

High-Speed Network". The tester generates a predetermined stream of digital data signals and transmits them onto all twisted-pair wires to which it is connected. Because the far end of these TP wires is open, the transmitted data signals are reflected back to the near end, if the TP wire is satisfactory for use in a high-speed LAN. (That is, without stubs, mismatches,...etc.) Attenuation of the reflected signal will occur, but will be compensated by a receiver portion of the transceiver.

The directional coupler will cause the attenuated reflected signal from a partial twisted-pair to be received by the transceiver. This received signal can then be compared against the transmitted signal and if the former is simply an attenuated copy of the latter, the particular TP wires are satisfactory for use in the high-speed LAN of Fig. 1.

In practice, the bit error rate (BER) of the received signal must be less than a predetermined value for the TP wire to be "good".

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram showing a Hub-Pod configuration of a LAN employing TP wires.

Fig. 2 illustrates the use of a cable tester employed in testing the TP wires of the LAN.

Fig. 3 is a block diagram of the cable-tester device of the instant invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to Fig. 1, a typical installation of a local area network (LAN) having a STAR topology will be used to describe the instant invention. The various elements shown in Fig. 1 are described in detail in the related, co-pending application "Crosstalk Reduction in Unshielded Twisted-Pair Lines" and such description is incorporated by reference herein. A set of unshielded twisted-pair (TP) ordinary telephone lines 20 interconnect a Hub 14 and a set of twenty-five Pods 18. Preferably, the lines 20 are pre-existing premises wiring in a building. And it is desired to test their suitability for use in the high-speed LAN of Fig. 1.

The twenty-five TP lines 20 originate at a 50-pin connecter which plugs into the Hub 14. The individual TP lines then run to various locations within the building to connect a Pod 18 to the Hub.

A test of these twenty-five pairs 20 is performed idn accordance with the instant invention by isolating the twenty-five TP wires 20, i.e., disconnecting the 50-pin plug from Hub 14 and leaving open the TP wires where they terminate and would normally connect to a Pod 18. In other words, the TP wires 20 are tested as they are normally found in a building without any equipment connected at either end.

With reference now to Fig. 2, a cable tester 30 constructed in accordance with the instant invention, as will be described hereinbelow, is connected to the 50-pin plug at which the twenty-five pairs of TP wires originate.

The cable tester 30 then generates a predetermined sequence of digital signals over all twenty-five TP wires 20. Since the far ends of all TP wires are open, the signals are reflected back to the cable tester. The cable tester 30 includes a directional coupler which can be selectively connected to one pair of the TP wires 20. In turn, each pair of the twenty-five TP wires 20 is connected to the receiver portion of the tester 30 via the directional coupler. Because the directional coupler causes the receiver section of the transceiver to receive only the reflected signal on this particular TP, the bit error rate (BER) in the reflected signal may be calculated from the transmitted signal. If the BER is below a predetermined level, the particular TP is considered satisfactory for use in the LAN. That is, it has no "stubs" nor mismatches.

The cable-tester 30 then is set to test the next TP wire, in turn, the sense that the directional coupler causes the receiver section of the transceiver to receive only the reflected signal on this next TP. In this manner, all twenty-five TP 20 can be tested in sequence.

In a preferred embodiment of the cable-tester 30, each test of a particular TP will take less than one second. So the overall test of all twenty-five TP wires will consume less than one minute.

The cable-tester 30 is preferably constructed as shown in block diagram of Fig. 3. A transmitter section of a transceiver portion 32 of cable-tester 30 is capable of generating a 10 million bit per second (mbps) sequence of signals (TX). These signals are conducted via a directional coupler 34 to all twenty-five TP wires 20 which are connected to cable-tester 30 via the 50-pin plug. A control block 36 can selectively connect the coupler 34 to one of the twenty-five TP wires. The reflected signal received on the selected TP wires is conducted via directional coupler 34 to the receiver section of transceiver 32. The receiver section then generates the received signal (RX) which is conducted to a comparer block 38. The TX signal generated by the transmitter portion of transceiver 32 is also conducted to comparer 38. Comparer 38 generates a visual indication at one of two light-emitting diodes (red) 40 and (green) 42 whether the particular TP wire is good. This evaluation is based on the BER of the received signal (RX).

Control 36 can then select the next TP wire for testing until all twenty-five pairs are tested. All blocks of cable-tester 30, other than directional coupler 34, are conventional and will not be described herein. Directional coupler 34 is preferably of the inexpensive design described in the related, co-pending application entitled "Transceiver Coupler for One-Pair Cabling of a High-Speed Network" and such description is incorporated herein by reference.

Claims

1. A method of testing unshielded twisted-pair (TP) wires (20) for suitability in interconnecting elements of a high-speed local area netword (LAN), each said TP wire having an open near end and a open far end, **characterized** by the steps:

a) transmitting at a predetermined bit rate a predetermined sequence of digital signals onto said near end of one of said TP wires;

b) receiving at said near end of said one TP wire a sequence of digital signals reflected from said far end;

c) comparing the sequence transmitted at step (a) and the sequence received at step (b); and

d) indicating suitability of said one TP wire if the comparison at step (c) resulted in a bit error rate (BER) less than a predetermined value, and indicating unsuitability otherwise.

2. A method according to claim 1, **characterized** in that steps (a), (b), (c) and (d) are performed selectively for each of said TP wires in said LAN, wherein step (a) calls for transmitting said predetermined signal sequence onto said near end of all said TP wires in said LAN and, wherein step (b) calls for receiving said reflected signal sequence from said selected one of said TP wires.

3. Apparatus implementing the TP wire-testing method of claim 2, **characterized** in that transceiver means (32) having a transmitter portion for generating said predetermined sequence of digital signals and having a receiver portion for receiving said sequence of reflected digital signals and for generating therefrom a sequence of received signals;

directional coupler means (34) connected to said transceiver means (32) and selectively coupled to said TP wire (20) to be tested for conducting from said transmitter portion said generated sequence of digital signals to said TP wire (20) and for conducting said reflected digital signals to said receiver portion;

comparer means (38) responsive to said signals generated by said transmitted portion and responsive to said received signals generated by said recover portion for generating a signal indicative of whether the BER is less than said predetermined value of not,

control means (36) connected to said directional coupler means (34) for selectively coupling said TP wire (20) to said directional coupler (34); and

indication means (40,42) responsive to said signal generated by said comparer means (38) for generating a sensory indicative of said suitability of said TP wire.

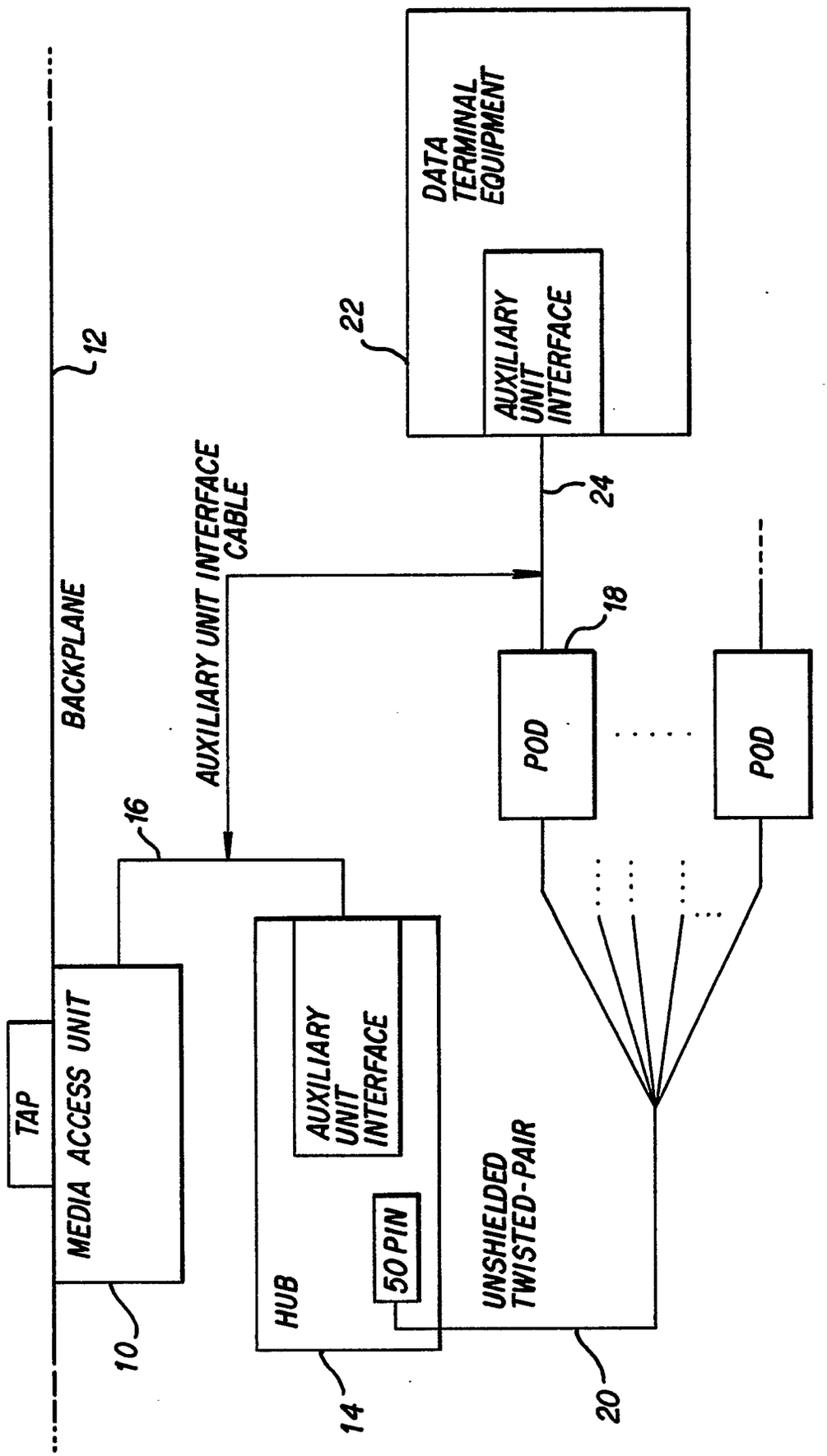
DATA TERMINAL EQUIPMENT
AUXILIARY UNIT INTERFACE
22
12
BACKPLANE
AUXILIARY UNIT INTERFACE CABLE
24
18
POD
POD
16
TAP
MEDIA ACCESS UNIT
AUXILIARY UNIT INTERFACE
HUB
50 PIN
UNSHIELDED TWISTED-PAIR
10
14
20

FIG. 1

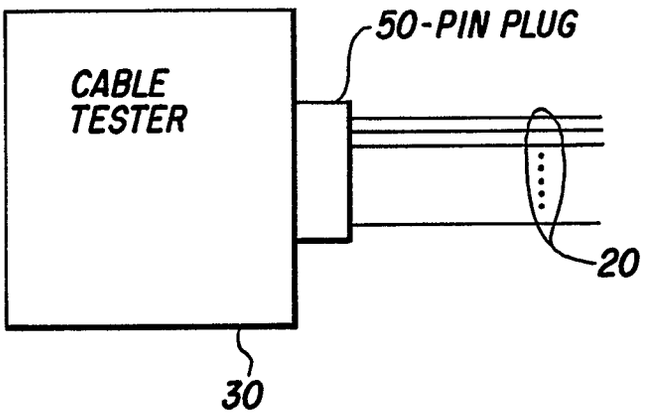
CABLE TESTER
50-PIN PLUG
20
30

FIG. 2

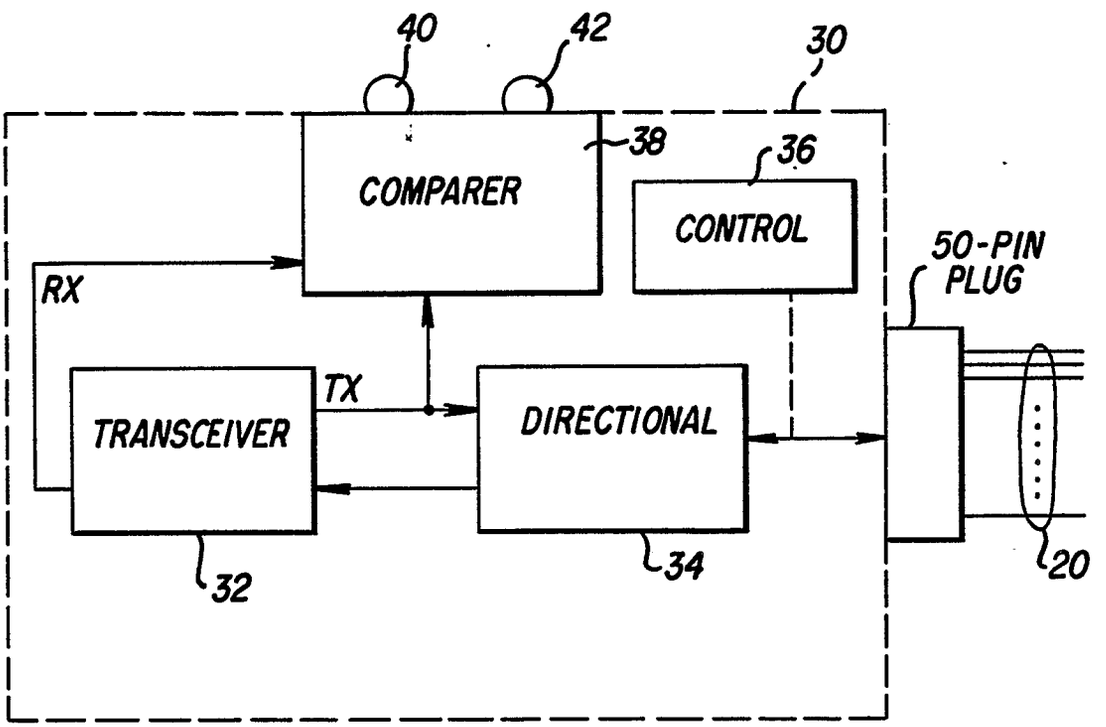
40
42
30
COMPARER
38
36
CONTROL
50-PIN PLUG
RX
TX
TRANSCEIVER
DIRECTIONAL
32
34
20

FIG. 3